

## Claims

We Claim:

1. A computer-implemented method for configuring a device to perform a measurement function, wherein the device includes a programmable hardware element, the method comprising:
- creating a graphical program, wherein the graphical program includes a block diagram, wherein the graphical program implements the measurement function;
- generating a hardware description based on the block diagram of the graphical program, wherein the hardware description describes a hardware implementation of the block diagram;
- configuring the programmable hardware element in the device utilizing the hardware description to produce a configured hardware element, wherein the configured hardware element implements a hardware implementation of the block diagram;
- the device acquiring a signal from an external source after said configuring;
- the configured hardware element in the device executing to perform the measurement function on the signal; and
- displaying one or more panels on a display during the configured hardware element in the device executing to perform the measurement function on the signal, wherein at least one of the one or more panels displays the measured signal.
2. The method of claim 1,
- wherein at least one of the one or more panels displays output from the device during said executing.
3. The method of claim 1,
- wherein at least one of the one or more panels comprises an indicator for displaying output from the device during said executing.

4. The method of claim 1,  
wherein at least one of the one or more panels is operable to receive user input for providing input to the configured hardware element during said executing.

5 5. The method of claim 4, further comprising:  
receiving user input to the at least one of the one or more panels during said executing;  
providing the user input to the configured hardware element; and  
the configured hardware element adjusting the measurement function on the  
10 signal in response to the user input.

6. The method of claim 1,  
wherein at least one of the one or more panels comprises a control operable to receive user input for providing input to the configured hardware element during said  
15 executing.

7. The method of claim 1,  
wherein the one or more panels comprise a user interface useable for viewing data generated by the device during the configured hardware element in the device executing  
20 to perform the measurement function on the signal.

8. The method of claim 1,  
wherein the one or more panels comprise a user interface useable for controlling the device and viewing output data from the device during the configured hardware  
25 element in the device executing to perform the measurement function on the signal.

9. The method of claim 8, the method further comprising:

receiving user input to at least one of the one or more panels on the display to control the device during the configured hardware element in the device executing to perform the measurement function on the signal.

5           10.     The method of claim 1,  
              wherein the one or more panels comprise a user interface for viewing output produced by the measurement function during the configured hardware element in the device executing to perform the measurement function on the signal.

10           11.     The method of claim 1,  
              wherein the one or more panels comprise a user interface for controlling the measurement function during the configured hardware element in the device executing to perform the measurement function on the signal.

15           12.     The method of claim 1,  
              wherein the device is coupled to a computer system, wherein the computer system includes the display;  
              wherein said displaying comprises the computer system executing software to display the one or more panels on the display during the configured hardware element in  
20           the device executing to perform the measurement function on the signal.

              13.     The method of claim 12, wherein the graphical program specifies the one or more panels;  
              the method further comprising:  
25           compiling a portion of the graphical program corresponding to the one or more panels into executable code for execution by the computer system.

              14.     The method of claim 1,

wherein said generating includes incorporating a register in the hardware description for at least one of the one or more panels;

wherein the configured hardware element in the device executing to perform the measurement function on the signal includes accessing a register on the configured hardware element to affect values displayed in one of said one or more panels.

15. The method of claim 1, the method further comprising:  
performing analog to digital conversion on the signal after said acquiring and prior to said executing.

16. The method of claim 1, wherein the device operates as an instrument.

17. The method of claim 1, wherein the device operates as a virtual instrument.

18. The method of claim 1, wherein the external source is a unit under test.

19. The method of claim 1, wherein the configured hardware element in the device executes to perform a process control function using the signal.

20. The method of claim 1, wherein the configured hardware element in the device executes to model a process.

21. The method of claim 1, wherein the device further includes timer/counter logic, the method further comprising:

the timer/counter logic performing one of timing / counting operations during the configured hardware element in the device executing to perform the measurement function on the signal.

22. The method of claim 1, further comprising:  
converting the hardware description into a net list; and  
compiling the net list format into a hardware program file;  
wherein said configuring the programmable hardware element includes  
5 downloading the hardware program file to the programmable hardware element to  
configure the programmable hardware element.

23. The method of claim 22, wherein said converting the hardware description  
into a net list includes:  
10 utilizing at least one function block from a library of pre-compiled function  
blocks; and  
utilizing hardware target specific information.

24. The method of claim 1, wherein said creating the graphical program  
15 includes:  
arranging on the screen a plurality of nodes comprising the graphical  
program;  
creating and storing data structures which represent the graphical program  
in response to said arranging;  
20 wherein said generating the hardware description comprises:  
traversing the data structures;  
converting the data structures into a hardware description format in  
response to said traversing.

25. The method of claim 1, wherein the graphical program includes a plurality  
of nodes;  
wherein said generating the hardware description comprises converting each of  
said nodes into a hardware description format.

26. The method of claim 25, wherein each of said nodes is converted into a hardware description format including an enable input, a clock signal input, and an enable output;

wherein, for a respective node, said enable input receives an enable signal  
5 generated from enable out signals from one or more nodes which provide inputs to the respective node.

27. The method of claim 25, wherein the graphical program includes an input terminal;

10 wherein, for said input terminal, said converting comprises:

determining if data input to the input terminal is from one of said one or more panels;

creating a hardware description of a write register, wherein the write register includes one or more data outputs and at least control output.

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28. The method of claim 25, wherein the graphical program includes a function node;

wherein, for said function node, said converting comprises:

determining inputs and outputs to/from the function node;

20 generating a hardware description of logic which performs the function indicated by the function node;

traversing input dependencies of the node;

creating a hardware description of an AND gate, including listing connections of said input dependencies of the node to said AND gate.

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29. The method of claim 25, wherein the graphical program includes a structure node;

wherein, for said structure node, said converting comprises:

determining inputs and outputs to/from the structure node;

generating a hardware description of a control block which performs the control function indicated by the structure node;

traversing input dependencies of the node;

creating a hardware description of an AND gate, including listing  
5 connections of said input dependencies of the node to said AND gate.

30. The method of claim 25, wherein the graphical program includes an output terminal;

wherein, for said output terminal, said converting comprises:

10 determining if data output from the output terminal is to one of said one or more panels;

creating a hardware description of a read register, wherein the read register includes one or more data inputs and at least control input.

15 31. The method of claim 1, wherein the graphical program comprises a plurality of interconnected nodes which visually indicate functionality of the graphical program.

20 32. The method of claim 1, wherein the graphical program comprises a data flow diagram.

33. The method of claim 1, wherein a first portion of the block diagram portion is converted into a hardware description;

the method further comprising:

25 compiling a second portion of the block diagram portion into machine code for execution by the processor;

the configured hardware element performing functionality indicated by the first portion of the block diagram portion;

executing the machine code to perform functionality indicated by the  
second portion of the block diagram portion;

wherein said executing the machine code and the configured hardware element  
performing functionality operate to perform functionality indicated by the block diagram  
5 portion of the graphical program.

34. The method of claim 1, wherein the device includes a non-volatile  
memory coupled to the programmable hardware element, the method further comprising:  
storing the hardware description into the non-volatile memory;  
10 wherein said configuring the programmable hardware element comprises  
transferring the hardware description from the non-volatile memory to the programmable  
hardware element to produce the configured hardware element.

35. A computer-implemented method for configuring a device to perform a  
15 measurement function, wherein the device includes a programmable hardware element,  
the method comprising:

creating a graphical program, wherein the graphical program includes a block  
diagram, wherein the graphical program implements the measurement function;

generating a hardware description based on the block diagram of the graphical  
20 program, wherein the hardware description describes a hardware implementation of the  
block diagram;

configuring the programmable hardware element in the device utilizing the  
hardware description to produce a configured hardware element, wherein the configured  
hardware element implements a hardware implementation of the block diagram;

25 the device acquiring a signal from an external source after said configuring;  
the configured hardware element in the device executing to perform the  
measurement function on the signal; and

displaying one or more panels on a display during the configured hardware  
element in the device executing to perform the measurement function on the signal,



wherein at least one of the one or more panels displays data output from the configured hardware element.

36. A measurement system, comprising:

5 a computer system comprising a processor, memory and a display;

wherein the memory stores a graphical program, wherein the graphical program includes a block diagram, wherein the graphical program implements a measurement function;

10 wherein the memory also stores a software program which is executable to generate a hardware description based on the block diagram of the graphical program, wherein the hardware description describes a hardware implementation of the block diagram of the graphical program; and

a device coupled to the computer system, wherein the device includes:

an input for acquiring a signal from an external source; and

15 a programmable hardware element, wherein the programmable hardware element in the device is configurable utilizing the hardware description to produce a configured hardware element, wherein the configured hardware element implements a hardware implementation of the block diagram of the graphical program, wherein the configured hardware element in the device is executable to perform the measurement  
20 function on an acquired signal;

wherein the computer system is operable to display one or more panels on the display while the configured hardware element in the device executes to perform the measurement function on the signal, wherein at least one of the one or more panels displays the measured signal.

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37. The measurement system of claim 36,

wherein at least one of the one or more panels displays output from the device during execution of the configured hardware element in the device.

38. The measurement system of claim 36,  
wherein at least one of the one or more panels comprises an indicator for  
displaying output from the device during said executing.

5 39. The measurement system of claim 36,  
wherein at least one of the one or more panels is operable to receive user input for  
providing input to the configured hardware element during said executing.

40. The measurement system of claim 39,  
10 wherein the at least one of the one or more panels is operable to receive user input  
during execution of the configured hardware element;  
wherein the user input is operable to be provided to the configured hardware  
element; and  
wherein the configured hardware element is operable to adjust the measurement  
15 function on the signal in response to the user input.

41. The measurement system of claim 36,  
wherein at least one of the one or more panels comprises a control operable to  
receive user input for providing input to the programmable hardware element during  
20 execution of the programmable hardware element.

42. The measurement system of claim 36, wherein the graphical program  
specifies the one or more panels;  
wherein the computer system is operable to compile a portion of the graphical  
25 program corresponding to the one or more panels into executable code for execution by  
the computer system.

43. The measurement system of claim 36,

wherein, in generating the hardware description based on the block diagram, the software program is operable to incorporate a register in the hardware description for at least one of the one or more panels;

5 wherein the programmable hardware element in the device is operable to access the register on the configured hardware element to affect values displayed in one of said one or more panels.

44. The measurement system of claim 36, wherein the device further comprises:

10 analog to digital conversion logic coupled to the input and to the programmable hardware element for performing analog to digital conversion logic on an acquired analog signal to produce a digital signal.

45. The measurement system of claim 36, wherein the device further includes  
15 timer/counter logic;

wherein the timer/counter logic performs one of timing / counting operations while the configured hardware element in the device executes to perform the measurement function on the signal.

20 46. The measurement system of claim 36, wherein the external source is a unit under test.

47. The measurement system of claim 36, wherein the configured hardware  
element in the instrument executes to perform a process control function using the signal.

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48. The measurement system of claim 36, wherein the software program stored in the memory of the computer system is further operable to convert the hardware description into a net list;

wherein the computer system is operable to configure the programmable hardware element utilizing the net list.

49. The measurement system of claim 48, wherein the software program  
5 stored in the memory of the computer system is further operable to compile the net list format into a hardware program file; and

wherein the computer system is operable to download the hardware program file to the programmable hardware element to configure the programmable hardware element.

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50. The measurement system of claim 36, wherein the programmable hardware element comprises a field programmable gate array (FPGA).

51. The measurement system of claim 36, wherein the computer system  
15 includes a bus and also includes one or more expansion slots coupled to the bus adapted for receiving expansion cards;

wherein the device comprises an expansion card inserted into an expansion slot of the bus.

52. The measurement system of claim 36, wherein the device is an external  
20 instrument coupled to the computer system.

53. The measurement system of claim 36, wherein the memory of the  
computer system stores a graphical programming system for creation of the graphical  
25 program;

wherein the graphical programming system is executable to arrange on the screen a plurality of nodes comprising the graphical program in response to user input;

wherein the graphical programming system is further executable to create and store data structures which represent the graphical program in response to said arranging;

wherein the software program is executable to traverse the data structures and convert the data structures into a hardware description format in response to said traversing.

5           54.     The measurement system of claim 36, wherein a first portion of the block diagram portion is converted into a hardware description;  
              wherein the computer system is operable to compile a second portion of the block diagram portion into machine code for execution by the CPU.

10           55.     The measurement system of claim 54,  
              wherein the configured hardware element is operable to perform functionality indicated by the first portion of the block diagram portion;  
              wherein the computer system is operable to execute the machine code to perform functionality indicated by the second portion of the block diagram portion;  
15           wherein said executing the machine code and the configured hardware element performing functionality operate to perform functionality indicated by the block diagram portion of the graphical program.

              56.     The measurement system of claim 36, wherein the device includes a non-  
20           volatile memory coupled to the programmable hardware element;  
              wherein the non-volatile memory is operable to store the hardware description;  
              wherein the non-volatile memory is operable to transfer the hardware description to the programmable hardware element to produce the configured hardware element.

25           57.     The measurement system of claim 36, wherein the device performs data acquisition / generation functions.

              58.     The measurement system of claim 36, wherein the device is a GPIB instrument.

59. The measurement system of claim 36, wherein the device is a VXI instrument.

60. The measurement system of claim 36, wherein the device is a serial instrument.

61. The measurement system of claim 36, wherein the device is a programmable logic controller (PLC).

62. The measurement system of claim 36, wherein the device is a fieldbus device.

63. The measurement system of claim 36, wherein the block diagram comprises a plurality of interconnected nodes, wherein the plurality of interconnected nodes visually indicate functionality of the graphical program.

64. The measurement system of claim 63, wherein the plurality of interconnected nodes are connected to specify data flow among the nodes.

65. A. computer-implemented method for generating a hardware implementation of graphical code, the method comprising:

creating a graphical program, wherein the graphical program includes a plurality of interconnected nodes, wherein the interconnected nodes visually indicate functionality of the graphical program, wherein the graphical program implements a measurement function;

generating a hardware description based on the graphical program, wherein the hardware description describes a hardware implementation of the graphical program,

wherein said generating includes generating a hardware description based on the structure node;

configuring a programmable hardware element utilizing the hardware description to produce a configured hardware element, wherein the configured hardware element  
5 implements a hardware implementation of the graphical program;  
acquiring a signal from an external source after said configuring; and  
the configured hardware element executing to perform the measurement function on the signal.

10 66. The method of claim 65, further comprising:  
displaying one or more panels on a display during the configured hardware element in the device executing to perform the measurement function on the signal, wherein at least one of the one or more panels displays the measured signal.

15 67. The method of claim 66,  
wherein the one or more panels are useable for viewing the signal.

68. The method of claim 66,  
wherein the one or more panels are useable for viewing input to and output from  
20 the programmable hardware element.

69. The method of claim 66,  
wherein the one or more panels are useable for manipulating input to and viewing output from the programmable hardware element.

25 70. The method of claim 66, further comprising:  
storing executable code corresponding to the one or more panels in a memory, wherein the executable code is executable to display the one or more panels on a display;

a processor executing the executable code from the memory to present the one or more panels on the display during the configured hardware element in the device executing to perform the measurement function on the signal.

5           71.    The method of claim 66, further comprising:

          wherein the graphical program includes a block diagram and one or more panels, wherein the one or more panels operate as a user interface for the graphical program;

          the method further comprising:

          storing executable code corresponding to the one or more panels in a  
10   memory, wherein the executable code is executable to display the one or more panels on a display;

          executing the executable code from the memory to present the one or more panels on the display during the configured hardware element in the device executing to perform the measurement function on the signal.

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